Space Weather Technical Forecast

Issued on Monday 13 January 2025 at 13:14 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight Chance of isolated M-class flares, slowly increasing. HSS enhancement likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low during the last 24 hours with only C-class flares recorded.

There are seven sunspot regions on the visible disc with AR3958 fading and AR3960 numbered in the southeast. AR3947 remains the most magnetically complex group, the evolution for this region appears steady however, or in slight decline. AR3959 continues to move into view around the northeast limb, with the initial classification of Hhx/Alpha so far maintained until we see any more evidence of a trailing portion, which could suggest an increased flare risk. Other regions remain smaller and simple with limited overall change.

No Earth-bound CME's were observed during this period.

Solar Wind / Geomagnetic Activity: Solar winds observed at L1 by ACE/DSCOVR have erratically risen through the period from 380km/s to 450km/s, with the likely onset of the HSS of CH08/- and potentially some transitory CME influence. The density of the solar wind was mainly average. The Interplanetary Magnetic Field, Bt, at weak to moderate levels, with a peak of 13nT around 13/0600 UTC. The north-south component, Bz, varying between -9nT and +10nT, with a sustained negative deflection between 12/2200 UTC and 13/0100 UTC. The Phi angle was mainly positive (away from the Sun) but became negative (towards the Sun) from around 13/0400 UTC. Geomagnetic activity was mainly Quiet (Kp 1-2), with an isolated Active (Kp 4) interval 13/0000-0300UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES-18 was at background levels. High energy electron flux (greater than 2MeV) at GOES16 was at background to moderate levels. The associated 24 hour fluence remained below the Active threshold on a generally flat trend, reading 1.06e7 integrated pfu at 13/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low, with a slowly increasing chance of isolated M-class flares and a very slight chance of isolated X-class flares, mainly due to AR3947 in the northwest disc or any spots that rotate over the eastern limb later in the period.

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Solar Wind / Geomagnetic Activity: Solar winds have been slowly rising, with observed speeds now around 440km/s. The expected source is thought to be a HSS enhancement associated with CH08/- in the west of the disc. Speeds most likely remaining at slightly elevated to elevated levels through Day 1 (13 Jan) into Day 2 (14 Jan). There remains a slight chance of a CME arrival early on Day 1, but this is highly uncertain. Solar wind speeds expected to gradually decrease back to background from Day 3 (15 Jan).

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp1-3) though Days 1-2 (13-14 Jan), but with a chance of Active (Kp4) intervals and a slight chance of isolated G1 to G2 Minor/Moderate Storms should any significant CME influence be forthcoming. Activity is then expected to return to Quiet to Unsettled (Kp1-3) levels from Day 3 (15 Jan) onwards.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to remain at background levels, with only a slight chance of rising in response to any notable flares. GOES-16 high-energy electron flux is anticipated to remain at background levels initially due to the influence of the HSS from CH08/-. Flux levels may then increase again to moderate to high levels towards the end of the period. Electron fluence is expected to remain below the active threshold throughout.

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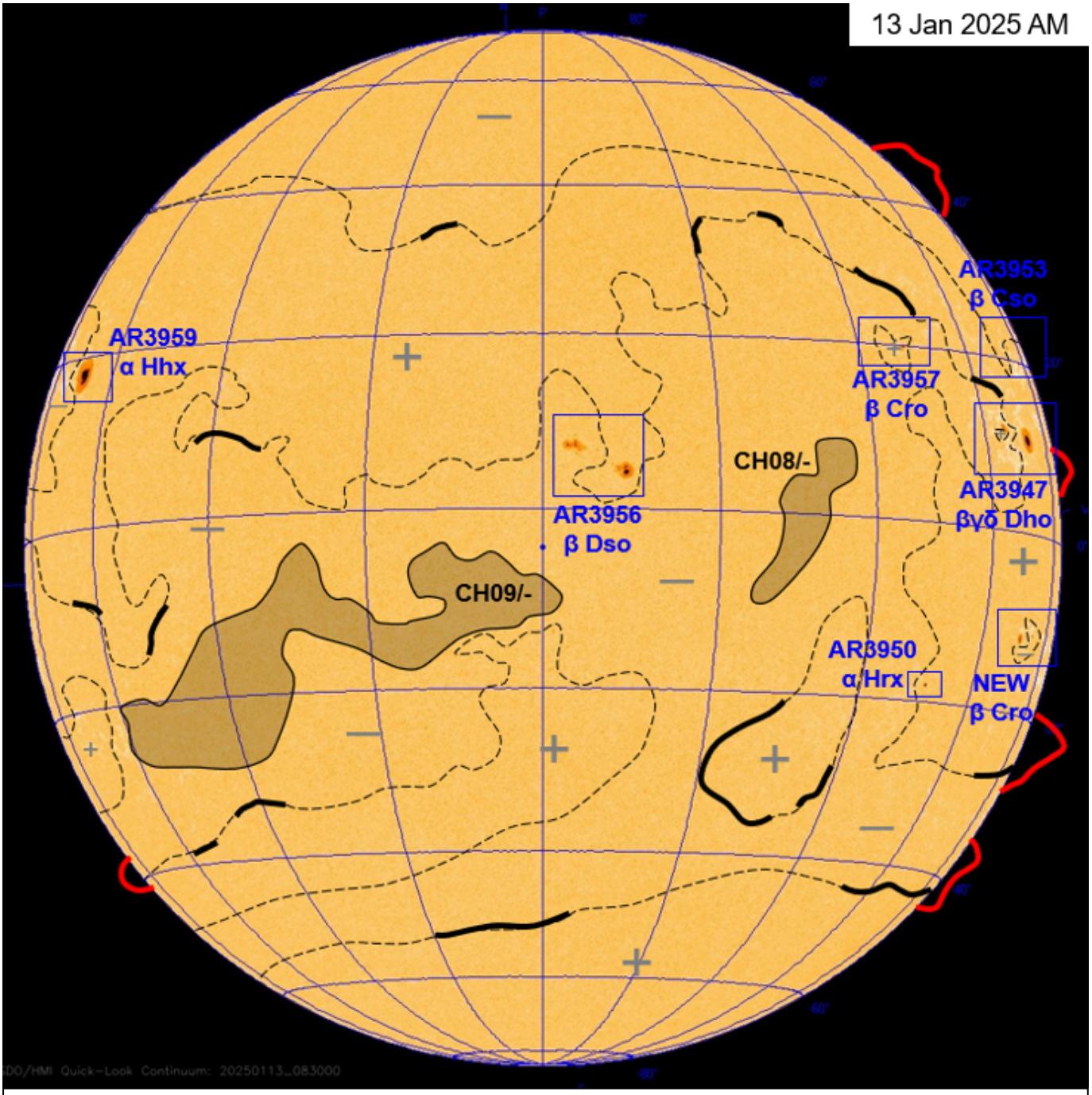
Figure 1: Solar Synoptic Map valid 13/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Solar winds have been slowly rising, with observed speeds now around 440km/s. The expected source is thought to be a HSS enhancement associated with CH08/- in the west of the disc. Speeds most likely remaining at slightly elevated to elevated levels through Day 1 (13 Jan) into Day 2 (14 Jan). This evolution notably different than indicated by MOSWOC's ENLIL model, which appears to overestimate both the onset time and longevity of CH08/-, as well as the associated HSS speed, with solar wind speeds expected to gradually decrease back to background from Day 3 (15 Jan).

A filament eruption to the northeast of AR3947 appeared on SDO/AIA 304 imagery and GONG H-alpha around 09/1030 UTC with an associated long duration C-class flare. Given the lack of SOHO and STEREO coronagraph imagery at the time, it is difficult to ascertain if any material was directed towards Earth as a result of this event. Given its location near centre disc, it was possible that we could have seen an Earth-directed component, however any CME would have likely reached earth by now. There remains a very slight chance of a further impact early on Day 1 (13 Jan), though this is highly uncertain. Due to this uncertainty, the potential CME has not been included in the "Earthbound Coronal Mass Ejections" table.

Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp1-3) though Days 1-2 (13-14 Jan), but with a chance of Active (Kp4) intervals and a slight chance of isolated G1 to G2 Minor/Moderate Storms should any significant CME influence be forthcoming. Activity is then expected to return to Quiet to Unsettled (Kp1-3) levels from Day 3 (15 Jan) onwards.

Geomagnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	15	10	5	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Radio Blackouts - X-Ray Flares

Solar activity has been Low during the last 24 hours with only C-class flares recorded.

There are seven sunspot regions on the visible disc with AR3958 recently fading. AR3947 remains the most magnetically complex group, with a Beta-Gamma-Delta magnetic classification reinstated for the trailing portion, the evolution for this region appears steady however, or in slight decline. AR3956 nearing centre disc remains a simple, mature region. Most of the other regions remain small and simple with limited overall change. AR3959 continues to move into view around the northeast limb, with the initial classification of Hhx/Alpha so far maintained until we see any more evidence of a trailing portion, which could suggest an increased flare risk.

Evidence of magnetic looping in SDO 171 imagery near the eastern limb suggests the potential for new regions to rotate onto the facing-disc in the coming days. Helio-seismic data is supportive of this and corresponds to expected locations for Ex-AR3929 and Ex-AR3933. These two regions were responsible for M-class flares when last on the disc in late December. AR3947, which currently dominates flare probability contributions, will rotate over the western limb on Day 2 (14 Jan) with a gradual decline in flare risk thereafter.

Overall, a slight chance of isolated M-class flares initially, this risk steadily increasing to a chance through the period as further regions are expected to rotate on. The risk of isolated X-class flares very slight but also increasing.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	No	20	25	30	35
Very Active	R3-R5 (X Class)	No	5	5	10	10

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Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has remained at background over the last 24 hours. There is a slight chance of an enhancement as AR3947, the most complex spot, continues to transit the western hemisphere during the forecast period, rotating off of the visible disc during Day 2 (14 Jan) but will present a risk of enhancement though the period. This region was previously the source of multiple M-class flares and isolated X-class flares, but with a reduction in significant flares recently. Risk expected to increase slightly later into the period as further sunspot regions are expected to rotate onto the disk, with a continued threat from AR3947 even as it rotates away.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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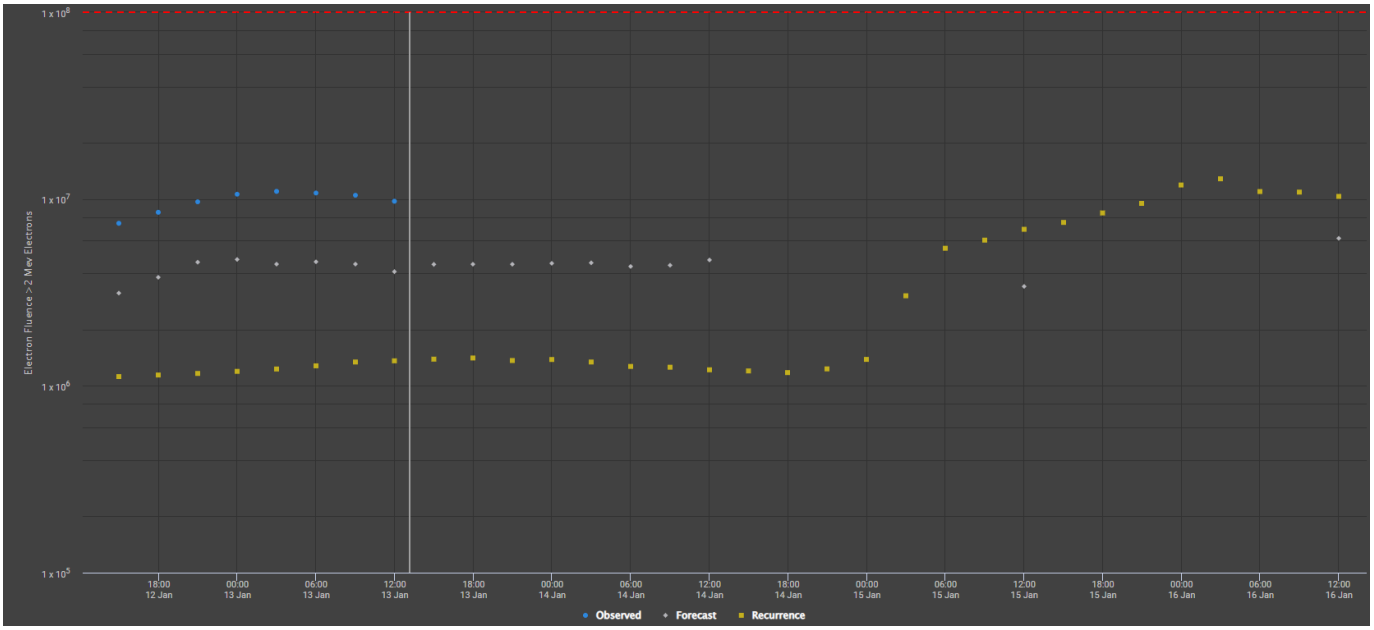
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at normal to moderate levels during the past 24 hours. The anticipated and perhaps ongoing arrival of the HSS from CH08/- early in the period is expected to suppress the electron belts away from GEO, with flux levels potentially only returning to moderate to high levels towards the end of the period.

Electron fluence is expected to remain below the active threshold, with REFM currently serving as a reasonable guide. There is a slight chance of a slight rise later in the period, although this is low confidence.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 2: Latest MOSWOC REFM model output.



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